Preface

In today’s global economy, there is an urgent need for a diverse engineering workforce representing self-confident and culturally literate individuals who are able to tolerate ambiguity as well as empathize with the socio-cultural nuances of different people groups. However, the engineering workforce does not typically mirror the demographic profile of their host society. For example, in the US, the high attrition rates from engineering programs for women, minorities and under-represented groups range from 49% – 62% and result in an engineering workforce that consist of 0.3% – 13% representation from this cohort. In stark contrast, women and minorities comprise more than half the U.S. population.

This issue of underrepresentation seems to be deeply entrenched in certain societal contexts; however, there are some global instances where women are in the engineering workforce. In places like the US where this deep-seated issue continues to baffle stakeholders, several strategies have been promoted. These include first-year seminars, internships, learning communities, and capstone projects. These are typically implemented piecemeal, targeting underpreparedness, without consideration for the other competing causative factors such as the lack of self-directing competencies.

The American Association of Engineering Education (ASEE) Board authorized 2014-2015 as the Year of ACTION on Diversity. ASEE is the world’s leading entity in engineering education and thus this designation of 2014-2015 was a mandate for the engineering world to include diversity as one the National Academy of Engineering’s Grand Challenges of Engineering. Diversity is inclusivity and so very much more, an idea that was highlighted by William A. Wulf in his annual report to the National Academy of Engineering in the early 2000’s. Diversity is strength in creativity, broadness of new ideas, and embracing new perspectives to arrive at the most truly innovative, resource-smart solutions possible. Diversity refers to “gender, race, ethnic background, disability, sexual orientation, gender expression, age, socio-economic status, nationality and other non-visible differences” such as personality, aspiration, learning style and motivation that Dr. Wulf refers to as individual differences (quotes from the ASEE Definition of Diversity).
With the engineering academy currently focused on minorities and underrepresented groups within the engineering profession, this publication is very timely. The key objective of this publication is to serve as a repository for global findings with respect to engineering education promotion across all education levels. This publication has the sub-objectives of investigating:

1. The impact of industry-engineering interactions to improve inclusion and diversity through all stages of the engineering profession
2. The use of specialized programs (such as study abroad) to retain diverse populations in engineering
3. The impact of student affairs on retention of minorities in engineering (e.g., student organizations)
4. The faculty-staff models that allow for successful recruitment-retention-graduation of diverse populations in engineering

The lack of minority and female representation in engineering majors and subsequent careers continues to be a seemingly entrenched challenge in the face of numerous well intentioned attempts. Changing the current trajectory and landscape requires the application of coordinated high impact strategies from global and diverse perspectives. This publication seeks success stories from around the world that involve combinations of K-12 preparation, re-engineering the current curriculum, the incorporation of experiential educational experiences such as study abroad, providing more underrepresented-friendly work environments and addressing barriers to women and minorities. This book seeks to integrate causation factors, barriers and challenges together with sets of holistic solutions that have shown successful application of a systems approach to addressing this challenge. Across twelve (12) chapters, the views and expertise of twenty six (26) authors are presented in this book. Their contributions span studies in Australia, North America, Europe, and Central America.

ORGANIZATION OF THE BOOK

Scholarly Value and Impact of Book

This book expands on the field of the engineering education. The main themes that the chapters in this book attempt to expand upon include:

- Diversity
- Inclusion
Target Audience

This book is a great resource for academic advisors and counselors in high school and colleges of engineering; faculty advisors in colleges of engineering; directors of multicultural and engineering student centers at the college level; students undertaking research in the area of administration of higher education; recruitment officers and student affairs/involvement professionals at colleges. As a secondary audience this publication would make for an excellent textbook resource for students that are studying for masters and doctorates in the administration of higher education.

The Content

There are twelve (12) original chapters in this book. These chapters were divided among three (3) sections. These sections are:

- **Section 1: High Impact Higher Education Pedagogical Frameworks and Practices** (three chapters)
- **Section 2: Micro-Community or Target Approaches to Diversifying Engineering** (five chapters)
- **Section 3: Critiques and Administrative Suggestions to Restructure Engineering Education** (four chapters)

The forewords are written by Mr. Noel Blackburn and Dr. Stephen R. Cox. Both of these gentlemen are, and have been, avid champions for diversity in engineering for many years at different institutions. In his foreword, Mr. Blackburn highlights the well understood concept of the “glass ceiling” and makes a case for making widespread the term “glass door” to expose, more fully, the disparity in participation of women and minorities in the engineering profession. Dr. Cox, in his foreword, confronts the ideology and thinking of “the broken” student and provides insights into proven metrics for diversifying STEM fields.
Section 1: High Impact Higher Education
Pedagogical Frameworks and Practices

In Chapter 1, Yvonne R. Hilton presents her study entitled “Improving Student Persistence”. Throughout higher education, student persistence is of major concern. Statistics show that the greatest percentage of attrition occurs after the freshmen year. Most studies that have been done took place at large predominately white institutions (PWIs). This study observed student satisfaction with institutional environment at Lincoln University. Lincoln is a small, historically black university (HBU) with less than 3000 matriculated students. Specifically, this study it looked at how the institutional environment may impact freshmen students’ decisions to return for their sophomore year. The results indicate that although freshmen students are dissatisfied with certain aspects of the environment they consider to be important, this generally had little if any influence on their decision to return.

Chandra A. Stallworth and Ken D. Thomas tackle the issue of recruitment and retention of underrepresented minorities at a large predominantly white institution (PWI) in Chapter 2 which is titled “Minority Recruitment and Retention Among Gifted Students”. In this chapter Stallworth and Thomas focus on the efforts of the Auburn University Honors College to recruit and retain underrepresented minorities at the highest academic echelons. The chapter delves into the creation of a minority support system that has now grow into a chartered student organization.

In Chapter 3, Monica Gray and Connie Lundy explore their study titled “Engineering Study Abroad: High Impact Strategy for Increasing Access”. Changing the current engineering workforce’s diversity portfolio is of grave national importance and requires a plethora of high impact approaches. One overlooked approach is study abroad. In this chapter the authors challenge and make their striking case for the inclusion of study abroad on the list of high impact approaches. They do this by discussing the benefits, opportunities and challenges in sending engineers abroad, exploring strategies to internationalizing engineering education, and examining how these can be achieved to ensure affordability, broad access, retention and program efficiency.

Section 2: Micro-Community or Target Approaches to Diversifying Engineering

“Empowering Women in STEM: Embedding STEM in K-12 Education” is the title of Chapter 4 which was co-written by Gretchen Dietz, Julie Hessidence, Terry Long, and Helen E. Muga. This group of civil and mechanical engineering students along with an engineering faculty member from University of Mount Union seeks to tackle the number of women involved in engineering by getting girls excited about
science, technology, engineering and math (STEM) in the K-12 school system. This chapter details the approaches used by this team in both the Ohio education system and the Panamanian education system. The impact of their work is also highlighted in this chapter.

Judith Gill, Mary Ayre, and Julie Mills of University of South Australia, Australia authored Chapter 5: “Revisioning the Engineering Profession: And How to Make It Happen!” In this chapter the authors argue that there is a great need to develop equity and inclusivity in engineering with particular emphasis on women in the workplace. This chapter highlights the barriers to women and minorities in the engineering profession and suggests a path to best get there based on the experiences of some Australian women engineers.

In Chapter 6, Melissa L. Johnson and Kristy Spear elaborated on a learning community as a high impact approach in their work titled “Developing a Learning Community of Engineers Through an Honors First-Year Seminar”. This chapter focuses on a first-year seminar for honors students that highlights the high impact practices students should participate in throughout their undergraduate career. By developing both formal and informal learning communities within the seminar, first-year students are exposed to opportunities, mentoring, and support that help them make informed decisions about their major and career. The authors found that providing this level of support and clarifying the opportunities that exist within the field of engineering through a first-year seminar course was a successful way to address this challenge and retain and graduate more engineering students.

“Engineering Teams: Supporting Diversity in Engineering Education Through Attention to Detail in Engineering Group Work Experiences in First Year” by Jennifer Loy and Simon Howell is presented in Chapter 7. Working in groups is an inevitable part of the engineering education experience. This chapter argues that an artificial method to establishing these groups during first year activities can reinforce majority dominance which only further goes against the inclusion and diversity that is being hoped for. This chapter provides alternative strategies for building groups in the first year that focus on team building, valuing diversity and cultural awareness. It also provides a framework for building on the initial activities that will support diversity throughout the degree program.

Jennifer Loy of Griffith University, Australia, presents her study titled “Addressing Cultural and Gender Bias in Set Project Work: Creating Project Diversity and Encouraging” as Chapter 8. This chapter considers the type of projects chosen for marketing engineering in schools and the set project work typically forming the basis of first and second year engineering education. This chapter provides a review of possible cultural and gender bias project work in Engineering education and provides strategies for redesigning project work that provides for a more diverse cohort.
Section 3: Critiques and Administrative Suggestions to Restructure Engineering Education

In Chapter 9, Aaron Sakulich and Amy Peterson explored “A Globally Focused, Experiential Education System for the STEM Fields”. In this study, the authors propose an outline for an educational system that would intentionally support STEM students regardless of gender, race, ethnic background, disability, sexual orientation, gender expression, age, socioeconomic status, nationality, or individual differences such as learning style and career aspirations. The authors purport that such a system would use Individual Development Plans (IDPs) in order to empower students to follow an intentional path during their studies as they explore career options, identify a mentoring network, and set overall career goals.

Linda Steuer, Anna Bouffier, and Sonja Gaedicke’s study titled “Diversifying Engineering Education: A Transdisciplinary Approach From RWTH Aachen University”, as presented in Chapter 10, critically analyzes an innovative approach of the Gender and Diversity in Engineering Institute (GDI) at RWTH Aachen University. RWTH Aachen University wants to open the way towards a more holistic and transdisciplinary approach of engineering. Through the integration of gender and diversity into engineering research and teaching there has been expansion with new perspectives and content providing an important potential for innovation generation. This allows the authors to conclude that engineers bear social responsibility and should take this into account by considering social diversity. However, this reasoning suggests that, in addition to the core engineering subjects, engineering curricula have to include disciplines which enable engineering students to see the related questions within societies they are developing their products for.

Chapter 11 makes the case for the emergence pathway programs for internationalizing US higher education campuses in the study titled “Engineering Pathways in a US Public Institution of Higher Education: A Strategy for Fostering Student Diversity”. Authors Fabiola Ehlers-Zavala and Anthony Maciejewski remark that “A pathway program is a program that has been designed to attend to the needs of a specific group of international students in their first year of education in the US. Pathway students are students that do not meet the criteria for direct entry into a university due to lower levels of English language proficiency and / or GPA. Therefore, these students need greater academic and language support to be positioned for success upon matriculation into the degree programs of their choice.” The author concluded that there is most certainly a need for these types of programs in US Colleges of Engineering to better prepare US students to enter the real world with greater cultural awareness and experience with diversity and inclusion.

In the book’s last chapter, Chapter 12, “Getting Off the Engineering Enrollment Rollercoaster: Example of Interaction Between Academia and Upstream Petroleum
Industry”, by Tatyana Plaksina, there was a main aim to examine the petroleum industry in the US and to determine how petroleum engineering programs can better interact with industry partners. This interaction is in hopes to allow for better diversity in the petroleum sector. In this chapter the author elaborates on the diversity of the students, inclusive of on a gender basis, as well as the faculty that are involved in teaching and research in petroleum engineering programs. In conclusion, the author suggests strategies for enhancing diversity of students and faculty based on integration approaches.

REFERENCES